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ABSTRACT

This study compared the typing efficiency of four young children (5 to 6 years of age) who were novice typists on the Dvork and QWERTY keyboards. A copying program on an Apple IIc microcomputer functioned as the training instrument. Although the children did not acquire proficient touch typing skills, they did type accurate responses faster, keep their hands positioned on the home row when they began typing, and show some conditioning to key locations when using the Dvorak keyboard. While the children's fingering was often inconsistent and they continued to glance at the keyboard for confirmation of key locations, their acquisition of touch typing skills would probably have been more extensive had they stayed with the same keyboard throughout instead of changing from the QWERTY to the Dvorak version. Although there is some evidence that children as young as 6 years can acquire touch typing skills, it is unclear what the recommended procedures should be for introducing young children to keyboard fingering. Additional research in this area acquires increasing importance as more young children use microcomputer keyboards. Twelve references, 2 tables, and 1 figure are included. (GL)

Comparing Children's Typing Skills Using the Dvorak and QWERTY Keyboards on a Microcomputer

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Running head: Dvorak and QWERTY Keyboards

Abstract

This study compared the typing efficiency of four young children, who were novice typists, on the Dvorak and QWERTY keyboards. A copying program on an Apple IIc microcomputer functioned as the training instrument. Although the children did not acquire proficient touch typing, they did type accurate responses faster when using the Dvorak keyboard. The results are discussed in terms of the advantages of using the Dvorak keyboard with young children.

Comparing the Use of the Dvorak and QWERTY Keyboards by Young Children

In the 1930s, August Dvorak and his colleagues designed a keyboard for touch typing to replace the standard QWERTY keyboard that was designed in the late 1870s before touch typing came in use (Dvorak, Merrick, Dealey, & Ford, 1936). The Dvorak keyboard increased the amount of home row typing, increased the number of words that were typed exclusively on the home row, reduced finger motions among rows, decreased the left hand overload, and decreased specific finger overloads. In the Dvorak arrangement of letter keys, only the letters A and M are in the same position as they are in the QWERTY arrangement:

Dvorak	P Y F G C R L
	A O E U I D H T N S
	Q J K X B M W V Z
QWERTY	Q W E R T Y U I O P
	A S D F G H J K L
	Z X C V B N M

Although the data vary on the degree of improvement offered by the Dvorak keyboard, there seems to be a general consensus in the research literature that it is a more efficient keyboard for touch typing (Joyce & Moxley, 1988; Yamada, 1980). In his review of the research, for example, Yamada (1980) estimates that Dvorak users type 15% to 20% faster than QWERTY users for timed copy-typing of limited duration and 25% to 50% faster in

routine production typing. Despite its increased efficiency, the Dvorak has not been adopted as a standard keyboard because initial costs can be high for replacing the keyboards and retraining typists.

With modern computers, however, keyboard conversion is much easier than it was in Dvorak's day, and retraining costs can be eliminated if touch typing is taught on the Dvorak keyboard from the beginning. Although this might suggest that all children should begin typing on the Dvorak keyboard, such may not be the case. A keyboard that is superior for touch typing (e.g. Dvorak) may or may not be superior for the hunt-and-peck typing of young children who are typing novices. For example, when fingers are positioned over the home row for ten-fingered typing, visual searching by novice typists should be more difficult on the Dvorak because the most frequently used keys are covered. In contrast, the most frequently used keys on the QWERTY keyboard are on the uncovered top row.

Because our review of the literature found no data that favored or disfavored the initial use of the Dvorak keyboard by young children, the following study sought to provide evidence that would help to resolve this issue. To do so, we looked at four young children's experience in copying printed words with the Dvorak and QWERTY keyboards in a naturalistic, after school setting over an 8 month period.

Method

Children and Setting

Four children were selected for instruction based on their age (5 to 6 years of age), good attendance, and little or no previous experience using typewriters or computers. Three of the children attended kindergarten for a half day program (Beth, 6 years, one month; Kathy, 5 years, 5 months; and James, 6 years, 3 months) and one child attended first grade (Julian, 6 years, 4 months).

Pre Assessment of Keyboarding Skills

An informal assessment requiring the children to type all the words they could from memory was used to initially assess keyboarding skills. Results of the assessment indicated that no child had knowledge of the keyboard arrangement as demonstrated by their visual scanning of the letters and skimming the rows of keys with a finger until locating a specific key. They primarily struck the keys with their index or third finger and frequently used the space bar inappropriately. Julian, for instance, pressed the space bar after 13 words but failed to press it after 7 words. Beth, the only other child to use the space bar, pressed it once in the middle of her name.

Experimental Design

In order to evaluate the efficacy of the two experimental conditions, a single subject ABAB design, in which the emphasis is on repeated objective measurement in a single individual over an extended period of time, was counter balanced to more clearly

identify order effects that might result when learning on one condition contributes to learning on another condition (Barlow & Hersen, 1984; Best & Kahn, 1989; Kazdin, 1982). Both experimental conditions, represented by the Qwerty and Dvorak keyboards, were implemented twice for a total of four phases per child (except for James who completed only three phases when his mother removed him from the day care center at the end of the academic year). Each phase consisted of approximately 20 sessions. After completing 20 sessions on one keyboard, the computer was converted to the other experimental condition by depressing a switch on the computer and rearranging the keys on tne keyboard. Twenty sessions later, the computer was re-converted. This process continued until all four phases were completed.

Procedures

Each day, before instruction began, the teacher reminded the children to tap lightly on the keys (as opposed to keeping the ke iepressed). They were also instructed to begin typing with their hands on the home row and to strike each key with the proper finger for touch typing.

Direct Copy Program. A Direct Copy program on an Apple IIc microcomputer, which was a version of programs developed to improve children's literacy skills, functioned as both a training and testing instrument for increasing typing frequency and accuracy (Moxley, 1986; Moxley & Barry, 1985; Moxley & Barry, 1986). The program presented vocabulary words that were

individualized for each child Approximately 15 words were available for each daily session and the computer randomly selected 10 of these words. The program was stopped after the child typed 10 words or when 4 minutes elapsed, whichever came first. Shorter words were used in the beginning of each phase and were replaced weekly by longer words as the children expanded their vocabulary. The vocabulary words were presented on the screen and were pronounced by a speech synthesis unit connected to the computer. Key presses were displayed on the screen and were recorded by the computer. Correct letters remained on the screen and were pronounced as a unit. The child received positive feedback for correctly typed words from the speech synthesis pronunciation of the word, praise from the teacher, and an automatic display of a star on the screen. Incorrect letters disappeared after a brief "flash" on the screen.

After the Direct Copy program was administered, a computer printout was made showing correct key presses for each word, incorrect key presses, seconds between the presentation of the stimulus and the first key press, seconds between each key press, and cumulative time elapsed since the stimulus was presented. Frequencies correct and incorrect were calculated by the computer so the data could be plotted on an equal ratio chart. The data were shared with the children and positive comments given for improvements in rate and accuracy.

Timed Samples. A timed sample of the student's typing of a printed passage, was administered by the teacher after the completion of each 20 session phase (with the exception of Julian's first phase because the initial plan was to use only the frequencies correct and incorrect from the Direct Copy program as the dependent variable). The timed sample consisted of one of five printed passages having the same words but in different order.

Results

Post Assessment of Keyboarding Skills

Although no child fully acquired touch typing, increases in keyboarding skills were observed. Such changes included keeping hands elevated over the home row of the keyboard, keeping the little fingers of each hand on the ends of the home row when lifting the hands to search for a key, consistently pressing the space bar between words, and quickly tapping a key rather than leaving the key depressed. Some good ten-fingered typing was acquired by Kathy. This, however, was still done mainly by looking at the keys rather than by touch.

Direct Copy Changes

Daily frequencies of correct and incorrect typing were compared across experimental phases. Frequency correct was defined as the number of correct key presses divided by the number of minutes. Frequency incorrect was defined as all incorrect key presses (except those errors created by the same

consecutive effect) divided by the number of minutes. Frequencies correct and incorrect were calculated for each vocabulary word and were totaled for each session. See Figure 1 and Table 1.

Insert Figure 1 and Table 1 about here

The Direct Copy data regarding celerations of frequencies correct showed advantages for using the Dvorak keyboard. The steepest accelerations occurred using the Dvorak keyboard for all four of the children (Julian = X1.5, Beth = X1.5, Kathy = X1.4, and James = X1.9). In addition, the accelerations on the Dvorak keyboard were always higher than the accelerations in the previous QWERTY phase. The QWERTY accelerations were also lower than the previous Dvorak accelerations except for Julian's third phase, which was slightly higher than the preceding Dvorak phase. The Dvorak celerations for frequency correct were steeper than the QWERTY, ranging from X1.2 to X1.9 with a median of X1.5, compared to X1.0 to X1.4 with a median of X1.2 on the QWERTY. All celeration lines were calculated using the Quarter-Intersect Method (Pennypacker, Koenig, & Lindsley, 1972). Frequencies for each session are displayed in Figure 1.

Although celerations of frequencies correct were higher for the Dvorak keyboard, celerations of frequencies incorrect were highly individual for most children and generally did not favor

either keyboard. James, however, was an exception. His data clearly favored using the Dvorak keyboard. His highest acceleration incorrect occurred in the QWERTY 1 phase, which was the same phase as his lowest acceleration of frequency correct. This was followed by his Dvorak 2 phase in which he had his highest acceleration of correct responses and lowest acceleration of incorrect responses.

The data also indicated the presence of order effects from experience with the keyboards. Higher accelerating frequencies across phases occurred in 7 of the 11 phase changes. The median frequencies correct also tended to increase across phases, with the exception that Beth and Kathy's fourth phases were lower than their third. Except for James, the greatest gain in frequencies correct occurred between the second and third phases.

Order effects were also demonstrated by step values, the measure of behavior change between the point where the celeration line of one phase ends and the point where the celeration line of the next phase begins (calculated by dividing the larger point value by the smaller value). Julian, Beth, and James exhibited greater step decreases in correct frequency celerations with each phase (see Table 1). The incorrect step values decreased across all phases for both Beth and James. These values also decreased for Julian and Kathy until the last

phase when both children showed a slight increase in the step values.

Further evidence of order effects were indicated by one child who showed keyboard control from the previous phase by striking keys that would have been correct on the keyboard in the previous phase. In his 4th (Dvorak) phase, Julian hit J for C in CAT (session 1), O for S in SAID (session 6), C for S in WATCHES (session 8), and H for J in JUMPING (session 14).

Posttests of Typing Speed

There was always a gain in frequencies correct on the posttests following the Dvorak phases but not always after the QWERTY phases. Kathy and James, for instance, had an increase in their frequencies of correct responses with each phase, while Julian and Beth had a decrease in frequencies correct on their second posttest (QWERTY keyboard). In addition, the gains in frequencies correct were always greater for the Dvorak than the QWERTY keyboard and errors were either nonexistent or less than those obtained on the QWERTY posttests. Typing was also more accurate in the Dvorak phases. Eleven of the errors occurred using the QWERTY keyboard (three by Julian and eight by Beth) while only one error (by Beth) occurred using the Dvorak keyboard. See Table 2.

Insert Table 2 about here

Discussion

None of the results supported the use of the QWERTY keyboards by novice typists even though home row finger positions would seem to favor visual searching on that keyboard. On the contrary, all the differences between the two keyboards favored the Dvorak keyboard, and the extent of the differences may have been suppressed by order effects.

Analysis of celerations of frequencies correct provided the strongest support favoring the Dvorak keyboard. The range and median of celerations correct on the Dvorak was higher than the range and median of celerations correct on the QWERTY. The steepest acceleration of frequencies correct for all children occurred on the Dvorak, and accelerations on the Dvorak were always higher than those of the previous QWERTY phase. This was not true of the QWERTY keyboard where the accelerations were lower than on the previous Dvorak accelerations with the exception of Julian's third phase. In the timed posttests, which are more conventional measures of typing efficiency, all the children had increases in frequencies correct in their Dvorak phases while two children had decreases in frequencies correct during a QWERTY phase.

Analysis of the celerations of frequencies incorrect also provides some support for using the Dvorak keyboard. For example, the ratio of errors between the QWERTY and the Dvorak keyboards on the posttests was 11 to 1 in favor of the Dvorak.

In addition, data from the Direct Copy program indicated that James's lowest accelerations incorrect always occurred on the Dvorak keyboard. Frequencies incorrect by the other children provided little support for either keyboard. One reason for this may be that key pressing errors are difficult to interpret in the Direct Copy data. Errors may have occurred when children inadvertantly pressed a key while the fingers were in the "touch" position, leaned on the keys, held a key down too long resulting in a repeated letter, or struck a key while waiting for the next word presentation. In addition, children sometimes struck a key after the word was presented but before the key press was registered by the computer, causing the child's second key press to be recorded as the child's first key press.

The fact that median frequencies correct and the step size for frequencies correct tended to increase across phases suggests an order effect that would tend to mask the differences between the keyboards. A history of instruction on one keyboard may have facilitated the acquisition of skills on the other keyboard up to the point at which conditioning to one keyboard interferred with performance on the other keyboard. In the first two phases, when children used hunt-and-peck typing with scanning, there was little interference from the previous keyboard. At this point, the children basically may have been acquiring greater fluency in scanning and identifying key locations. By the third phase, the students benefitted from

retraining on the first keyboard. In the fourth phase, the retraining on the previous keyboard and the acquisition of conditioned responses may have interferred with the next retraining.

Because our study found no evidence favoring the initial use of the QWERTY keyboard by young children, the argument for introducing young children to the Dvorak keyboard from the beginning receives further support. Indeed, all the evidence in favor of one keyboard over the other, modest as it is, is in favor of the Dvorak keyboard. Stronger evidence in favor of the Dvorak keyboard would be expected when children acquired more touch typing skills.

Even though the children in this study did not acquire touch typing proficiency, they did keep their hands positioned on the home row when they began typing and showed some conditioning to key locations. Their fingering, however, was often inconsistent and they continued to glance at the keyboard for confirmation of key location. Their acquisition of touch typing skills would probably have been more extensive if they had stayed with the same keyboard. Although there is some evidence that children as young as six years can acquire touch typing (Kaake, 1983), it is unclear what the recommended procedures should be for introducing young children to keyboard fingering (Hoot, 1986). Additional research in this area acquires increasing importance as more young children use microcomputer keyboards.

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TABLE 1

Phase Celerations, Median Phase Frequencies and Phase Steps of Frequencies Correct

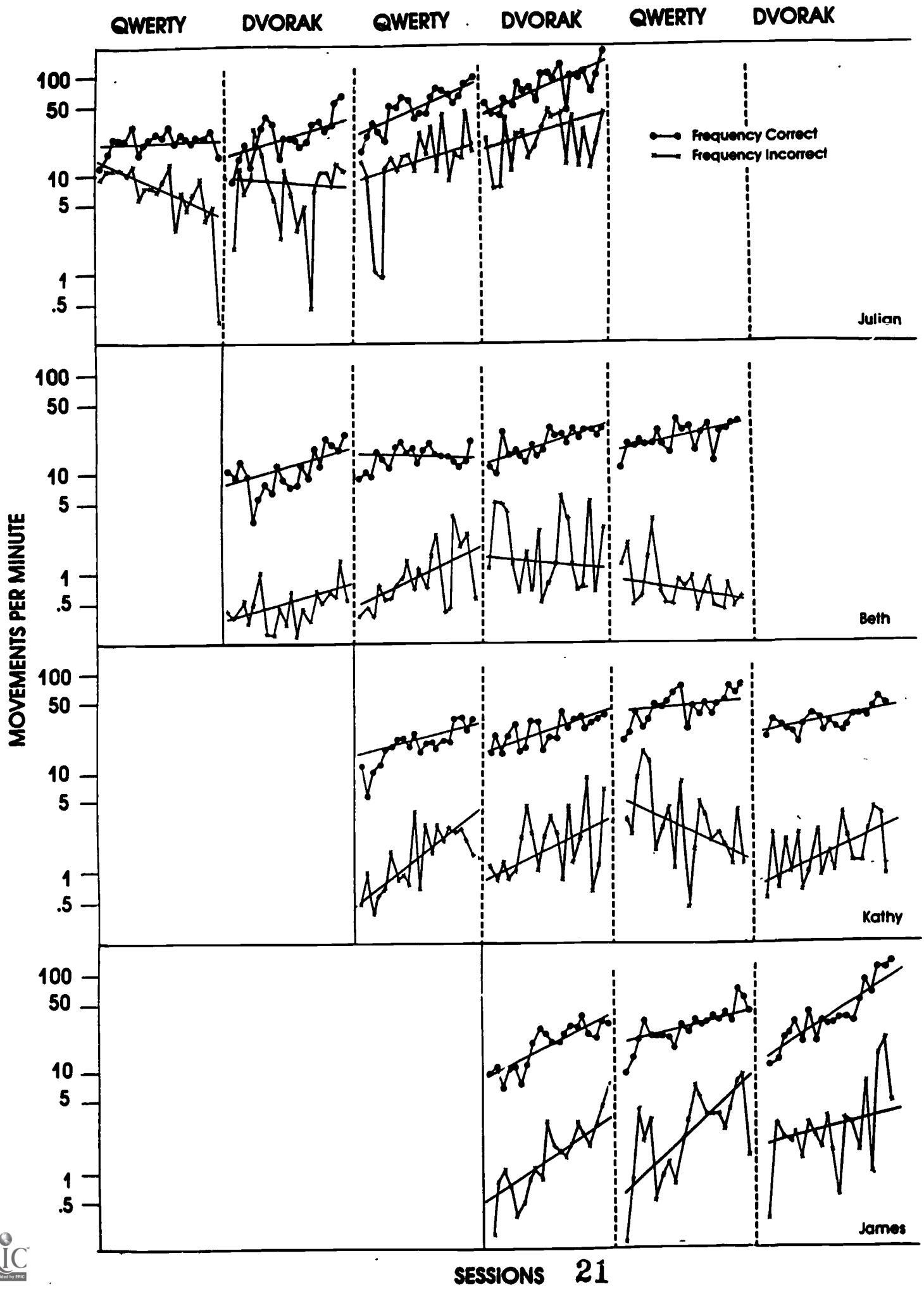
Child	QWERTY	Dvorak	QWERTY	Dvorak	QWERTY	Dvorak
Phase Celerations						
Julian	x1.0	x1.3	x1.4	x1.5		
Beth		x1.4	÷1.0	x1.5	x1.2	
Kathy			x1.3	x1.4	x1.0	x1.2
James				x1.5	x1.4	x1.9
Median Phase Frequencies						
Julian	20.88	22.97	45.11	63.83		
Beth		10.22	16.38	22.77	20.58	
Kathy			20.58	28.26	41.82	30.27
James				21.46	31.76	33.66
Phase Steps	Q/D	Q/D	Q/D	Q/D	Q/D	
Julian	÷1.2	÷1.5	÷2.3			
Beth		÷1.1	÷1.2	÷2.3		
Kathy			÷1.8	÷1.1	÷1.7	
James				÷2.1	÷2.8	

TABLE 2
Posttests showing Frequencies Correct (FC), Frequencies Incorrect (FI) and Errors

SUBJECT	Dvorak	QWERTY	Dvorak	QWERTY	Dvorak
JULIAN					
FC	54.49	35.74	58.28		
FI	--	1.28	--		
Error/correct	--	WAALKING/WALKING GRIL/GIRL SEEL/SEES	--		
BETH					
FC	11.16	11.9	13.17	18.54	
FI	0.19	0.88	--	0.22	
Error/correct	WALKNG/WALKING	IISSSSSSSSSSS/IS WSSLKING/WALKING WATH/WITH SEESD/SEES B;OY/BOY THH/THE	--	TEE/THE	
KATHY					
FC		7.07	24.26	31.94	35.77
FI		--	--	--	--
Error/correct		--	--	--	--
JAMES					
FC			14.80	16.42	25.41
FI			--	--	--
Error/correct			--	--	--

Figure Captions

Figure 1. Frequencies correct and incorrect for each child during the experimental phases for the QWERTY and Dvorak conditions. Celeration lines are drawn for each phase.


QWERTY
DVORAK
QWERTY
DVORAK
QWERTY
DVORAK
100
50
10
5
1
.5
Frequency Correct
Frequency Incorrect
Julian
Beth
Kathy
James
MOVEMENTS PER MINUTE
SESSIONS